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ABSTRACT

The influences of United Kingdom (UK) science teachers and careers advisers on students' decisions about science subjects and science and technology (S&T) careers were examined through a survey completed by 155 (55% of the target sample) career advisers to year 11 pupils in 7 careers service companies and case studies of a sample of 6 diverse schools located throughout the UK. Follow-up interviews with managers in each company were also conducted. Science teachers appeared to have a major influence on pupils' motivation toward and employment in science. This influence was exerted in the following ways: experiences in sciences classrooms; extracurricular activities initiated by science departments; and information about the content of post-16 courses and strategies for coping with advanced studies. Most careers-related activities for pupils in years 9-11 concerned the processes of subject options and work experience choices. All the schools were encountering difficulties in securing work experience placements in science and engineering for year 10-11 pupils. Those schools that were successful in securing placements drew heavily on contacts with parents, governors, and ex-pupils. Twenty recommendations regarding improving students' awareness of S&T-related educational and career opportunities were

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offered to schools, local careers service companies, national policymakers, and school science departments. (MN)

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Choosing Science at 16

The Influences of Science Teachers and Careers Advisers on Students' Decisions about Science Subjects and Science and Technology Careers

Decisions are taken about science subjects very early in school, often well before their implications are understood. Yet these decisions can significantly affect subsequent careers. If pupils are to be helped to keep science options open, both science teachers and careers advisers have important roles to play.

This Briefing:

- identifies national concerns about the uptake of science subjects;
- analyses how science departments and careers programmes influence the choice of science subjects;
- sets this in the context of other influences;
- recommends steps that need to be taken by schools, by careers companies and at national level.

The Briefing is based on a research project initiated and carried out by Mary Munro (NICEC Fellow) and David Elsom (NICEC Associate). The project was funded by the Department for Education and Employment, the Engineering Employers Federation, and the Engineering and Marine Training Association, with support from the Royal Academy of Engineering and the Salters' Institute. The views expressed do not necessarily reflect the views of the sponsors.

NICEC

The National Institute for Careers Education and Counselling is a network organisation initiated and supported by CRAC. It conducts applied research and development work related to guidance in educational institutions and in work and community settings. Its aim is to develop theory, inform policy and enhance practice through staff development, organisation development, curriculum development, consultancy and research.

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The Careers Research and Advisory Centre is a registered educational charity and independent development agency founded in 1964. Its education and training programmes, publications and sponsored projects provide links between the worlds of education and employment. CRAC has sponsored NICEC since 1975.

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CONTEXT

WHY SCIENCE IS IMPORTANT

- The economy needs a continuous supply of highly educated scientific and technological manpower, including teachers.
- Skills such as data handling, analysis, problem solving and IT, imparted through training in science, are also sought after by employers in many areas of work.
- Everyone needs to understand as far as possible the technological objects and processes we are surrounded by at home, at work and elsewhere.
- In a democracy, as many people as possible should be enabled to participate in informed debate about the increasing number of important issues which involve science and its consequences.

DIFFERENCES FROM OTHER SCHOOL SUBJECTS

- Knowledge of science and mathematics builds up gradually. Once 'dropped', mathematics and physical science subjects are much harder to return to later.
- Many young people cut themselves off from a whole range of scientific, technical and semi-technical careers because they find out too late that they need science qualifications to gain entry.
- Subject and career are perceived as being more closely linked in science, at the expense of its recognition as part of cultural development or general education.

TRENDS IN SCIENCE UPTAKE

Since the introduction of the National Curriculum in 1988:

- More pupils than ever before study science to GCSE (over 80% of both sexes), and an increasing number (plus an increasing percentage of the age cohort) stay on to study A-level subjects, Highers or equivalent post-16 qualifications.
- However, there has been no increase in the percentage of the cohort in England and Wales who have chosen to study physical sciences at A-level. In Scotland there has been a small increase in the uptake of all sciences at Higher level.
- The percentage of the age-group in England and Wales taking only mathematics and science subjects has halved, whilst the percentage taking a mixture of science and arts subjects and 'new' A-level subjects has steadily increased.

Concern about the uptake of science and engineering subjects at university level is not a new phenomenon. Over decades there have been many national and local initiatives aiming to raise the profile of science and engineering. Despite these initiatives, the uptake of physical sciences has declined; there are also concerns about the quality of entrants.

INITIAL QUESTIONS

The initial questions influencing the start of the project were:

- How many careers advisers have a background in science or technology?
- Do careers advisers see any difference between advising pupils about science and technology, compared with other areas of study and work?
- Do school science teachers feel they are the best people to advise would-be science or technology students?

BOUNDARIES

The scope of the project was confined to school pupils in Years 9 to 11, and the influence of careers advisers and science teachers on their decisions about subjects and courses post-16. Choices made at this stage significantly affect the available range of future courses and careers.

METHODOLOGY

Two main methods were used: a questionnaire to careers advisers; and six case-studies of particular schools. The work was carried out in five stages.

1. Five focus groups of careers advisers were held to 'scan the ground' with practitioners and listen for the appropriate language to use in the questionnaire.
2. The initial questions and the ideas from the focus groups framed the questionnaire to careers advisers. This covered the careers advisers' experience, educational and employment background, awareness of science in schools, and confidence in discussing science and related careers with students and teachers.
3. The questionnaire was sent to careers advisers working with Year 11 pupils in seven careers service companies. The 155 responses represented 53% of the target group.
4. The data were analysed and followed up by telephone interviews with managers in each of the companies to clarify some local contextual issues.
5. Case studies were prepared of six very different schools in different parts of the country. All were visited for two days each.

SCIENCE DEPARTMENTS

TEACHERS

Science teachers appeared to have a major influence on pupils' motivation towards and enjoyment of science, through the pupils' experience of science in the classroom and through extra-curricular activities initiated by science departments.

Science teachers were also influential through providing information about the content of post-16 science courses, and through discussing with individual pupils and their parents how the pupils would cope with more advanced study.

Science teachers did not see themselves as a source of information or advice about careers in science and technology. They did not feel able to keep up with careers information: there was a 'careers person' to do this. The teachers had little direct interaction with the careers adviser.

Taking science and mathematics as part of a deliberate strategy to keep options open was not often promoted by teachers. At Year 9, these were compulsory core subjects for pupils. At Year 11, many teachers saw career choices as the most important aspect of the pupils' decisions.

In the case-study schools there were many committed and enthusiastic science teachers keen to help pupils to achieve success in science and to inspire them to study further. However, many reported that their ability to enthuse pupils about science at Key Stage 4 was limited by:

- The time constraints imposed by a dull and content-driven National Curriculum.
- The difficulty of providing fun/interesting practical work due to strict health and safety requirements and large classes, combined with the continuous assessment demands of GCSE.
- The apparently lower intellectual challenge of GCSE science for very able pupils, when compared with some humanities subjects.
- Continual time pressure squeezing out extra-curricular activities such as visits and science clubs, and wider-ranging discussion about current science issues.
- Shortage of well-qualified teachers, particularly in physics.
- Other powerful factors to do with attitudes to science and science-related careers which were external to the school.

PUPILS' REACTIONS

Science was usually enjoyed by pupils in the case-study schools up to Year 9. Few pupils regretted that they had to study science up to the end of Key Stage 4.

Those who planned not to take science further said they had made up their minds by the end of Year 10, based mainly on their experience of science in the classroom.

Those who had decided to do science were either very keen on the subject, or in some cases had found out about a particular career that had caught their interest and for which they knew they needed science – medicine being a common example. As one teacher put it: 'they need a reason for doing science'.

There was little evidence that pupils were aware of explicit links being made in GCSE science lessons between science topics on the one hand and careers or industrial/medical applications on the other, although the teachers said they tried to do this.

Neither the idea of choosing sciences post-16 because of the ensuing flexibility of career and course choice, nor the concept of the value of the transferable skills gained from science subjects, had much appeal to pupils.

CAREERS ADVISERS' LINKS WITH SCIENCE

The careers advisers' survey revealed considerable variation (ranging between 5% and 50%) in the proportion of pupils reported to have asked about science-related careers in Year 11 interviews (the average was 18%). The careers advisers reported that this variation was related both to the academic level of the school and to differences in the whole-school ethos about science.

Several careers advisers mentioned their concern about pupils' lack of interest in science and low level of awareness of the links between science and jobs. They felt that the Year 11 careers interview came too late to influence this.

The careers advisers' responses to the survey showed very little planned contact with science teachers, unless the teacher had a pastoral role, or the careers co-ordinator or guidance teacher happened to be a scientist.

There were few examples of planned co-operation between the careers adviser and science department on activities designed to enhance younger pupils' opportunity awareness in science-related areas. Opportunities for contact between science teachers and careers advisers were:

- Parents' evenings.
- Conventions and industry days.
- Occasional joint training sessions for careers advisers and subject teachers.

CAREERS EDUCATION AND GUIDANCE

CAREERS PROGRAMMES

Whilst the school staff articulated much wider educational aims for the careers programmes, in practice Years 9-11 activities in careers work were much concerned with the processes of subject options and work-experience choices.

The issuing of school-produced explanatory booklets and other magazine-style booklets provided by DfEE, together with parents' evenings, were well-established and usually timely processes built into the programmes.

In Year 9, the main emphasis in the choice process was given to the optional subjects. The 'core' subjects (English, mathematics and science), which are compulsory for all, received less attention. Some of the schools' information booklets about Year 9 choices did not mention core subjects at all.

The ethos in all the schools seemed to be that pupils would do well if they chose subjects which interested them.

Group work sessions in Year 9 tended to be about option choices in general, or about how to find out careers information, rather than about specific career or job areas.

> 'We don't talk about the science course at all. We don't need to. It's compulsory. We don't need to discuss it, and anyway the pupils wouldn't be thinking about its career importance at Year 9. The whole point of our option scheme is to give a broad and balanced curriculum that leaves doors open. Therefore any emphasis on one particular subject is not part of it.'
> *(Science teacher)*

WORK EXPERIENCE

- All the schools were finding difficulties in securing work-experience placements in science and engineering for Years 10/11 pupils because of the insurance and the health-and-safety issues, and also in some cases because of lack of local science-based employers.
- Schools which reported success in finding such placements drew heavily on contacts through parents, governors and ex-pupils.

CAREERS INTERVIEWS

Pupils had 'voluntary' access to an interview with the careers adviser (or careers teacher) in Years 9 and 10. This was taken up by a small proportion – usually less than 10%.

In the maintained schools at the time of the survey it was expected that all pupils would have a careers interview at the end of Year 10 or in the first term and a half of Year 11. Staff valued the opportunity for all pupils to have access to an interview with a careers adviser as a part of the process of choice at Year 11, and were anxious about rumours circulating at the time (spring/summer 1999) that this arrangement would soon cease.

For many pupils their individual interview came after they had decided they did not want to continue with some, or all, of their science subjects.

The pupils reported that they found interviews with the careers advisers more helpful when they wanted confirmation of a career choice and more information about routes towards a goal already chosen. Many pupils said they would have liked more career suggestions from the adviser.

Careers advisers were drawn into the 'follow your interests' approach because their strategy in careers interviews was to work from the positive and identify the pupil's interests and strengths.

INSTITUTIONAL FACTORS

The recent growth in the importance of 'league tables' has reinforced schools' need for students to achieve high grades. Sciences predominate among the most severely graded subjects. Schools and colleges were therefore tempted to collude with students pursuing non-science subjects that they already enjoyed, or new subjects which pupils believed they would enjoy, without undue comment about the career options being closed down or the general skills which could be acquired by taking sciences. One of the case-study schools could not attract sufficient applicants to sustain an A-level physics group.

CAREERS ADVISERS AND SCIENCE

The careers advisers' survey showed that:

- The majority of the careers advisers were graduates with a humanities or social science background. One in ten had science degrees, all in biological subjects, and there were two engineers; there were no graduates in mathematics or physical science.
- 88% of the respondents reported significant employment experience before becoming a careers adviser. Few rated this as giving useful insights into science and technology, except more recent entrants who had used information technology in their previous jobs.
- The careers advisers' understanding of science and mathematics provision in schools and its implications for careers interviews was very variable.
- Length of experience and the demand from clients interested in these career areas seemed to be more important in building up confidence about science and technology than the careers adviser's own background.

- Careers advisers relied considerably on personal networks of friends and family for their confidence in discussing science and technology subjects and careers.
- There is a lack of systematic training and updating in occupational information now available to careers advisers. Where time was provided for visits or in-service training, the impact on confidence was evident.

> 'Working in a target-driven environment, there is little time to do any research. The other issue is we know about jobs and careers we are always asked about. It is not time-efficient to study careers we are never asked about by pupils. We see many pupils who want to be nursery nurses and car mechanics, and very few who want to do engineering.'
>
> *(Careers adviser)*

OTHER INFLUENCES

The other influences most frequently mentioned by pupils, teachers and careers advisers were:

- parents and family;
- image of science subjects;
- image of jobs in science and engineering;
- the history (recent and past) of the local labour market;
- gender;
- the media.

CONCLUSIONS

From the evidence collected, it appears that pupils have to make subject choices which so crucially affect their future options at a time when their motivation in science subjects is reducing and their perceptions of what for many are largely invisible careers are very hazy.

Lower motivation means that pupils are less likely to seek objective information for themselves. So it is largely chance that determines whether an individual's interest might be engaged in some aspect of science and technology sufficiently to persuade them to keep their minds open to the option of sciences, at least until the end of Year 11.

These chances can be increased by good teaching, by extra-curricular activities within school, and by careers education and guidance. But other influences – including those from outside school – may well prevail.

The concepts of transferable skills from science, and of the range of options available to people with science qualifications, are difficult to relate to for this age-group and for many of their parents.

RECOMMENDATIONS

FOR SCHOOLS

- Schools should strengthen the links between science departments and careers departments by, for example, appointing a science teacher with particular responsibility to co-ordinate and promote the links between science and careers through the curriculum, extra-curricular activities, information and resource dissemination, and external links with employers.
- High priority should continue to be given to events designed to stimulate interest and to inform students about science and engineering in Years 7-10.
- Links between science topics, applications in the home and at work, social issues and environmental issues need to be made more explicit in science activities from Year 7 onwards.
- Careers departments should help with this through more focused group work with Years 9 and 10 pupils and through closer working with science teachers and employers.
- Teacher placement schemes should be re-instated or expanded, particularly for science teachers involved in setting up partnerships with local companies.
- Where health-and-safety regulations, insurance problems or lack of local opportunities cause difficulties in providing Years 10-11 work-experience placements for pupils interested in science and engineering, alternatives such as work shadowing, work observation, work simulation, short courses or other projects should be considered.
- Local opportunities should be sought for pupils to have contact with holders of some higher-level jobs relating to science. Past students and governors are a useful resource here. There are growing opportunities for making contacts through the Internet.
- Schools should be more proactive in their work with parents, particularly in helping them to understand the implications of dropping career-relevant subjects and how continuing to study science does not restrict pupils to a science career.

FOR LOCAL CAREERS SERVICE COMPANIES

- Careers advisers should use more of their time in schools to develop their understanding of the schools' approach to the science curriculum and to increase their ability to draw out examples for pupils of relatedness to jobs.
- Careers advisers should build up close working relationships with science teachers in order jointly to develop curriculum enhancement and to work with local employers and others in designing events that will broaden pupils' concepts and horizons.

- Careers advisers should be encouraged to do more career-specific group work with Years 9 and 10 or even earlier. Time to do this could be switched from the Year 11 interview programme.
- Careers service companies should make provision for careers advisers to have a variety of appropriate methods (events, employers' groups, contact with professional bodies, job studies, reading and research) to develop individually, and collectively within the company, their own knowledge of occupations.

FOR ACTION AT NATIONAL LEVEL

- Contracts between careers service companies and the DfEE should be more flexible to allow careers advisers to work in different ways in different schools. More time could be spent on working with teachers and younger pupils in order to increase awareness of science and technology occupations before motivation in these subjects decreases in Years 9 and 10.
- Contracts between careers service companies and the DfEE should take account of the need for careers advisers to be continually updating their knowledge of fast-changing occupations and industries, and sharing this with colleagues and with teachers. The importance of this work should be underpinned by quality standards for careers companies and careers advisers.
- Quality standards for careers education programmes in schools need to reflect the importance of effective links between careers and subject departments, particularly in science where careers consequences are so far-reaching and issues such as image, gender, stereotyping and transferable skills are so important.
- A national campaign is needed to help parents understand the broader values of science subjects as important aspects of a general education, for their career importance, and for the flexibility and transferability of skills into a range of different work areas.
- University careers advisory services and engineering and science organisations should help schools and careers advisers to ensure that pupils and their parents have access to simple but accurate and balanced information about, for example, salaries and career development of those with science and engineering qualifications.

SCHOOL SCIENCE

- Future revisions of the National Curriculum in science should aim to release curriculum pressure, allow more flexibility in choice of topics, and give more emphasis to practical applications and links to work, with more hands-on approaches.
- Special attention is needed to physics, which is seen in England and Wales as a hard subject that lowers pupils' confidence within the double-award science course and as a difficult A-level which is graded more severely than other subjects. It is also a subject where many schools cannot find qualified teachers. The many initiatives to address these problems should be encouraged, but within an overall high-profile and well-funded national strategy for developing science education in schools.
- Alternative ways to enable pupils to 'learn through doing', both in the classroom and on work experience, or some alternative programme to help younger pupils to experience applications and job areas related to science, need to be explored and good practice shared. Employers' organisations, training organisations and other organisations aiming to raise the profile of science and engineering have a vital role to play here.

FURTHER INFORMATION

Copies of the full research report are available:

Munro, M. & Elsom, D. (2000). *Choosing Science at 16*. NICEC Project Report. Cambridge: CRAC.

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